Advances In
and Specifications for
Radiographic X-Ray Systems
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Applications of Radiographic Systems

- **Routine examinations**
  - Chest, Abdominal, Skull, Neck/Spine, Limbs

- **Emergency Services**
  - ER, ICUs, Neonatal ICU, Hospital Wards

- **Specialty Radiographic Examinations**
  - Dental, Mammography, Intraoperative
Routine Examinations

Chest X-ray

- Most common
  - 50% of all X-rays

- Evaluation of
  - Lungs
  - Heart
  - Chest Wall

- Quite difficult to interpret
Routine Examinations

Bone Radiography

- Second Most Common

Evaluation of
- Broken bones
- Sports injuries
- Orthopedic pre-surgery issues
Kidneys, Ureters, Bladder (KUB)

- Abdominal Exam
- Evaluation of
  - kidney stones
  - GI disorders

DOES NOT show Ureters
Routine Examinations

Upper GI

- Requires Barium
- Evaluation of
  - Esophagus
  - Stomach
  - Duodenum
  - First part of small intestine
Routine Examinations

Lower GI

- Evaluation of
- Bowels
- Colon

- Barium & Air
  often used
Routine Examinations

Intravenous Urography (IVU)

- Evaluation of
  - Urinary System

- Requires
  - Intravenous Contrast
Arthrography
- Evaluation of
  - Joints
- Uses Contrast
  - Contrast agent
  - Air
Dental X-rays

• Bitewing
Dental X-rays
- Panoramic Studies
Specialty Radiographic Exams

Cephalometric Studies
Mammography
Specialty Radiographic Exams

- **Dual Energy Absorptiometry (DEXA)**
  - **BMD studies**
Future Trends in Radiography

- The Impact of Digital Technologies
- “Turf Wars”
  - Changing practice guidelines as other imaging modalities mature (CT, MRI, US)
- The Influence of 3D Imaging
Digital Technologies

Dental DR Sensors (intraoral)
Influence of 3D Imaging

3D CT MRA
The Role of Intended Use in Defining Radiographic Systems Specifications

- Radiographic Units for Routine Exams
- Dedicated X-ray machines
  - Chest, Skull
- Special Purpose Machines
  - Tomographic Systems, Mobiles, Portables
- Niche Applications
  - Mammography, Pediatric, Dental
Universal Trauma Unit
Dedicated Chest Unit
Dedicated Skull Unit

Dulac System
Tomographic Unit

Simplified
Grossman
System
Mobiles & Portables

Mobile... ...Portable
Mammography System
Neonate X-ray Studies

Mobile unit used for X-ray studies of neonates
Specifications for Different Subsystems

- Generators
- X-ray Tubes
- Mechanical Subsystems
  - Tables, Stands, Buckys, Collimators
- Control Elements
  - User Interface, Interlocks
**Performance Specs**

**Radiographic Units**
- 50 to 125 kVp (150 kVp for Chest)
- 25 to 1000 mA (50 to 300 mA GP units)
- 20 to 100 kHz HF generators

**Mammography Units**
- 24 to 35 kVp, 100 mA typical

**Mobiles (Portables)**
- 50 to 125 (50 to 110) kVp
- 25 to 100 (15 to 25) mA

**Dental:** 70 kVp, 10 mA
Generators

Key Issues
- Range of Clinical Examinations
- Expected Workload
- Desired Lifetime
- Available Budget
Generators

Configuration Issues

- Mains Specifications, Power Rating
- Number of Tubes Supported
- Filament Supply Board
  - LFS & SFS support, Preheating modes
- Stator Type
- AEC Device Parameters
- Other Options
AEC Devices

AEC Pickup Assembly
X-ray Tubes

X-ray Tube Subsystem
X-ray Tubes

Glass Insert

Metal Insert
X-Ray Tubes

Cathode
Filament
X-ray Tubes

Stator Assembly
X-ray Tubes

Crucial Specs for an X-ray Tube

- Power ratings (kW)
- Focal Spot sizes
- Maximum kVp
- Target Angle
- Heat Capacity
Mechanical Subsystems

Patient Tables
Mechanical Subsystems

Patient Tables
Mechanical Subsystems

Tube Mounts
Mechanical Subsystems

Bucky Mounts
Mechanical Subsystems

Collimator
Operator Interface

System Console
Operator Interface

Interface Design
Paradigm
Operator Interface

Paradigm Shift?
Interlocks
Advances in Technology

High Frequency Generators
Recent Advances in Technology

Dose Optimization Methods

- Spectral Filtration

Entrance Spectra    Exit Spectra

without
+ 0.1mm Cu

with
Advances in Technology

Dose Optimization Methods

- Dual Energy Sensing
New Requirements

Generator and Tube Ratings

- Flexibility in Handling a wide Range of Patient Sizes
  - Large Output Reserves

- Image Quality Optimization with Effective Dose Management
  - Robust Collimation
  - Spectral beam shaping
New Requirements

Challenges in Exposure Control and Image Quality for DR Systems

Phototiming Subsystem Design
- Traditional AEC subsystems
- Integrated on board AEC circuitry

![Diagram showing sensor, collector electrode, measurement pixels, and dose pixels.]
New Requirements

Challenges in Exposure Control and Image Quality for DR Systems

- **Scatter Control for Digital Receptors**
  - Traditional Solution
    - Fixed grid in front of image receptor
  - Future approach
    - Antiscatter measures incorporated into image detector assembly
New Requirements

PACS Interfaces

New Challenges Due to Different Nature of Data

- Image Transfer and Preservation of Associated Data
- Workflow Handling
Any Sufficiently
Advanced
Technology is
Indistinguishable
from Magic

Arthur C. Clarke